ValveLink™ 8 & 16

User's Manual

Version 2.2

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AutoMate Scientific, Inc.

ValveLink8 - Part #01-18

For indoor use only from 5° to 40° C.
Do not get wet or subject to visible condensation.
Clean with a mild soap solution with a damp cloth only.

This equipment must be earth grounded. Use any of the screws on the bottom of the case. See page 12.

Do not unplug valves while on!
Do not attempt to repeatedly cycle valves on and off in under 10 milliseconds.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Supply voltage:
ValveLink8 controller = 12 V AC up to 2.4 Amps @ 50-60 Hz
External power supplies:
USA & Japan = 110 V AC up to 0.26 Amps @ 60 Hz
European = 220 V AC up to 0.17 Amps @ 50 Hz

Internal battery type: 3V Lithium coin battery
type BR2325 coin or CR2032

23mm x 165mAh

Please replace fuse with standard 2.5 Amp (M) medium-time / blow fuse.

CE

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The ValveLink is intended for research use only.

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Josef Kewekordes II, Heath Lukatch, Dave Ilstrup, Gabriel Stern

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Introduction

FOR RESEARCH USE ONLY

The ValveLink is designed for solution-switching use in research applications ONLY. AutoMate Scientific, Inc. cannot be responsible for injury or death resulting from medical or pharmacological use.

Hardware Overview

The ValveLink™8 and 16 are simple digital/manual valve controllers designed for use with research automation software. Valves can be controlled by digital TTL* signals from any I/O card or device. Eight pushbuttons allow manual user control with eight bi-colored LED indicators (16 LED's for ValveLink16's plus a 'bank' selector switch described later). A serial (RS-232) port is provided for further valve control by serial devices. All three input sources (digital, serial, and push buttons) are simultaneously active, and the LED's constantly display the current valve status.

The ValveLink is designed to drive 12 volt DC solenoid valves plugged into RCA jacks on the back of the box. Why not connect valves directly to your computer? Several reasons:

1) Most computer interfaces provide +5V signals – not strong enough to drive most valves (6 to 12V DC and up).
2) Computer interface signals are often too noisy for electrophysiology amplification. The ValveLink is designed with special low noise circuitry to minimize interference with high-gain amplification.
3) Finally, many solenoid valves are designed to be opened with a short, full-voltage pulse, then "held-in" with a lower voltage to keep the valves from heating. The ValveLink automatically provides dual-voltage hold-in.

* TTL stands for Transistor-Transistor Logic, a +5/0 volt standard for representing on and off – used by the ValveLink for computer valve control.

ValveLink Laboratory Applications

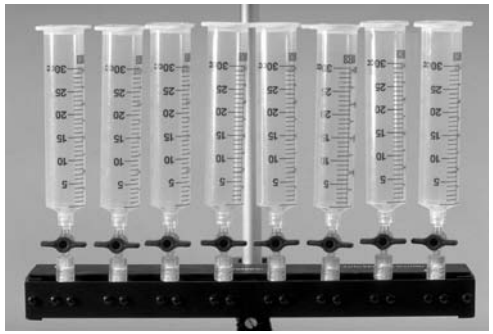
Perfusion
A ValveLink can be programmed to precisely switch solutions perfusing over biological samples for physiological research. The ValveLink's circuitry is designed to open valves with low noise for electrophysiological amplification. Several features, 'Modes' have been built into the ValveLink for advanced perfusion use.

Washing
Combined with an AutoMate ported washing tray, the ValveLink can automate washing of electrophoresis gels and blots, and developing of x-ray or photographic film or prints. You have complete control over which washing steps of your Western, Northern, Southern, Coomassie Blue and Silver staining runs are automated and which are handled conventionally. Unattended washing can save a busy lab countless hours of tedious monitoring.

Liquid Chromatography
A ValveLink can be easily programmed to automate solution selection in multi-step ion exchange, gel filtration or affinity chromatography runs with excellent reproducibility. The ValveLink is especially useful in preparative work when a protocol has been established and programmed to repetitively isolate your valuable molecule.

Luer lock Valves and Syringe Reservoirs

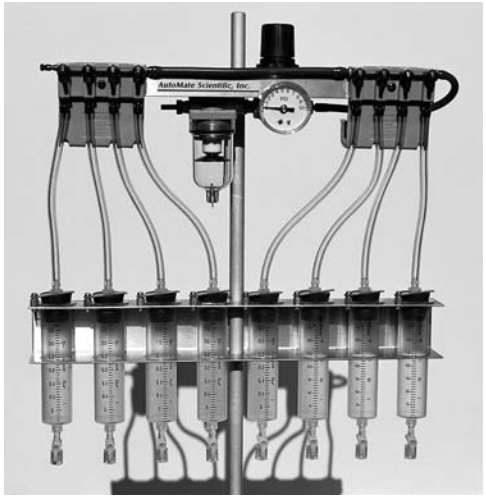
AutoMate also offers valves with luer lock fittings for direct connection of syringes. This method eliminates wasted solution in tubing between the reservoirs and valves. Small 2-way stopcocks are included when this option is ordered.



Pressure Regulated Perfusion System

AutoMate Scientific now offers a Pressurized Perfusion Upgrade with either four or eight channels for:

- Faster Switching
- Microliter fine delivery
- Small diameter pipette delivery
- Steady flow-rate
- Microinjecting



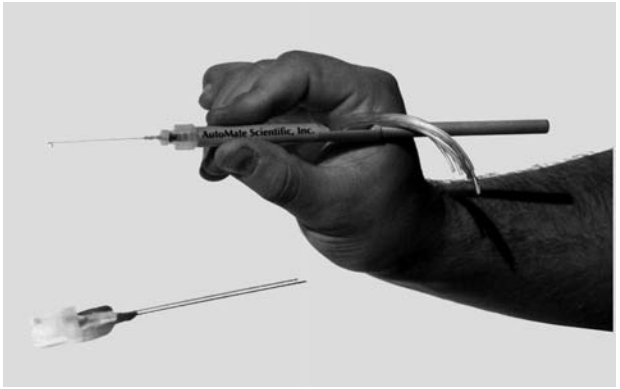
The package can be added to any new or existing perfusion rig - from AutoMate, any third-party manufacturer, or even homemade. Connect to house air, tank, or compressor (30 to 100 psi). Precision regulator delivers zero to 10 psi.

For Single-cell or Whole-cell Superfusion

Multi-barrel Perfusion Pencil™

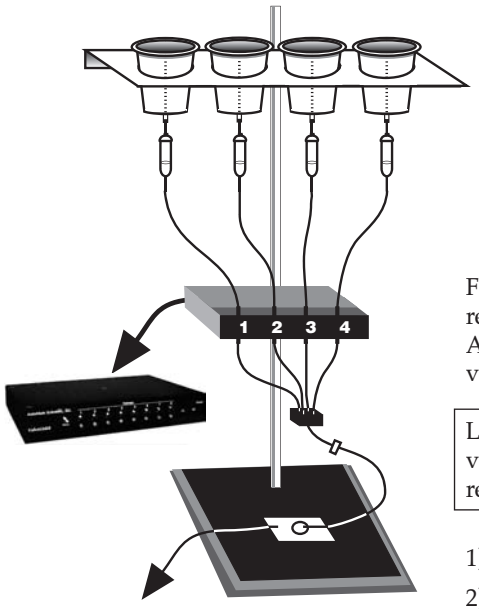
8 micro-bore tubes into 1 outflow

- Single cell and patch delivery
- Rapid solution change
- Micro-liter dead volume
- 250 & 100 micron removable tips



System Set-up Diagrams

Perfusion System



vacuum trap

Instructions on this page for Economy perfusion systems, Lure-lock fittings, Pressurized systems or Pinch valve systems. (Regular hose barb Teflon perfusion systems please see the next page.)
Lure-lock systems should also see photo on page 3. Find additional photos and diagrams of the pressure system on pages 4 and 8.

Flow rate adjusted by relative height of reservoirs and included flow regulator. Always calibrate flow rates - regulator values are relative (see below).

Leave tubing between reservoirs and valves long enough to raise and lower reservoirs.

1) Assemble ringstand.
2) Attach valve unit.
3) Attach reservoir bracket(s).
4) Insert reservoirs.
5) Attach provided tubing to upper valve barb (cut as desired, but see note above first).
6) Connect tubing between bottom valve barbs and manifold.
7) Connect flow regulator tubing to manifold outflow and your perfusion chamber (downsizing if necessary).
8) Plug numbered valve cables into ValveLink ports.

Calibrate flow rates by running one line into a graduated cylinder for a fixed period of time.

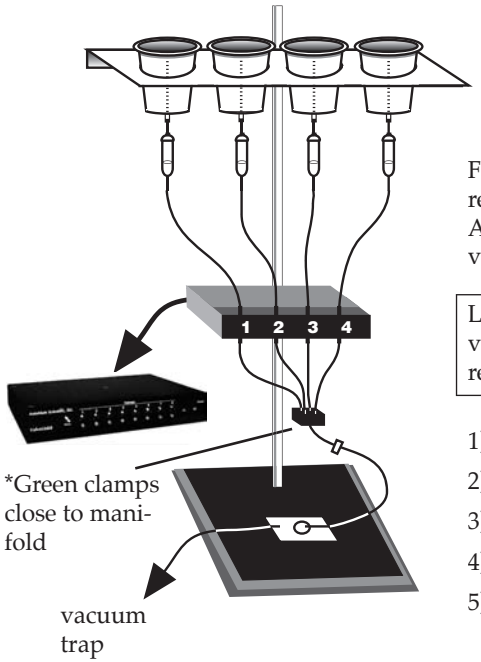
*Unused lines should be replaced with plugs on manifold, or temporarily clamped-off just above manifold to avoid back bleeding into empty lines.

Priming one line at a time reduces bubbles.

Connect your vacuum trap line directly to the outflow of the manifold for running cleaning solutions and drying your lines quickly.

Determine dead volume from the manifold to sample by measuring time and volume required to flush a colored liquid with a clear one.

Standard Teflon Perfusion System (without pressure)



Flow rate adjusted by relative height of reservoirs and included flow regulator. Always calibrate flow rates - regulator values are relative (see below).

Leave tubing between drippers and valves long enough to raise and lower reservoirs.

1) Assemble ringstand.
2) Attach valve unit.
3) Attach reservoir bracket(s).
4) Insert reservoirs.
5) Insert short pieces of 3/16 i.d. tubing over tops of drippers, then insert over reservoir nipples.
6) Attach dripper tubing to upper valve barb (cut as desired, but see note above first).
7) Insert green clamps on short pieces of 1/16 tubing.
8) Connect tubing between bottom valve barbs and manifold.
9) Connect flow regulator tubing to manifold outflow and your perfusion chamber (downsizing if necessary).
10) Plug numbered valve cables into ValveLink ports.

*Unused lines should be replaced with plugs on manifold, or temporarily clamped-off just above manifold to avoid back bleeding into empty lines.

Priming one line at a time reduces bubbles.

Connect your vacuum trap line directly to the outflow of the manifold for running cleaning solutions and drying your lines quickly.

Determine dead volume from the manifold to sample by measuring time and volume required to flush a colored liquid with a clear one.

Calibrate flow rates by running one line into a graduated cylinder for a fixed period of time.

Teflon Micro-manifold Use

Your valves should be equipped or retrofitted with 1/16" o.d. outflow hose barbs. Micro-manifolds are shipped with a short piece of 1/16" o.d. tubing in each hole (inputs and outflow). You can either connect the valves to manifold inports with a piece of 1/16" i.d. tubing over both the valve barbs and short pieces of manifold tubing:

Valve with 1/16" o.d. barb
v
1/16" i.d. tubing over barb
and over manifold short tubing
v
Manifold with short pieces of 1/16" o.d. tubing in each port

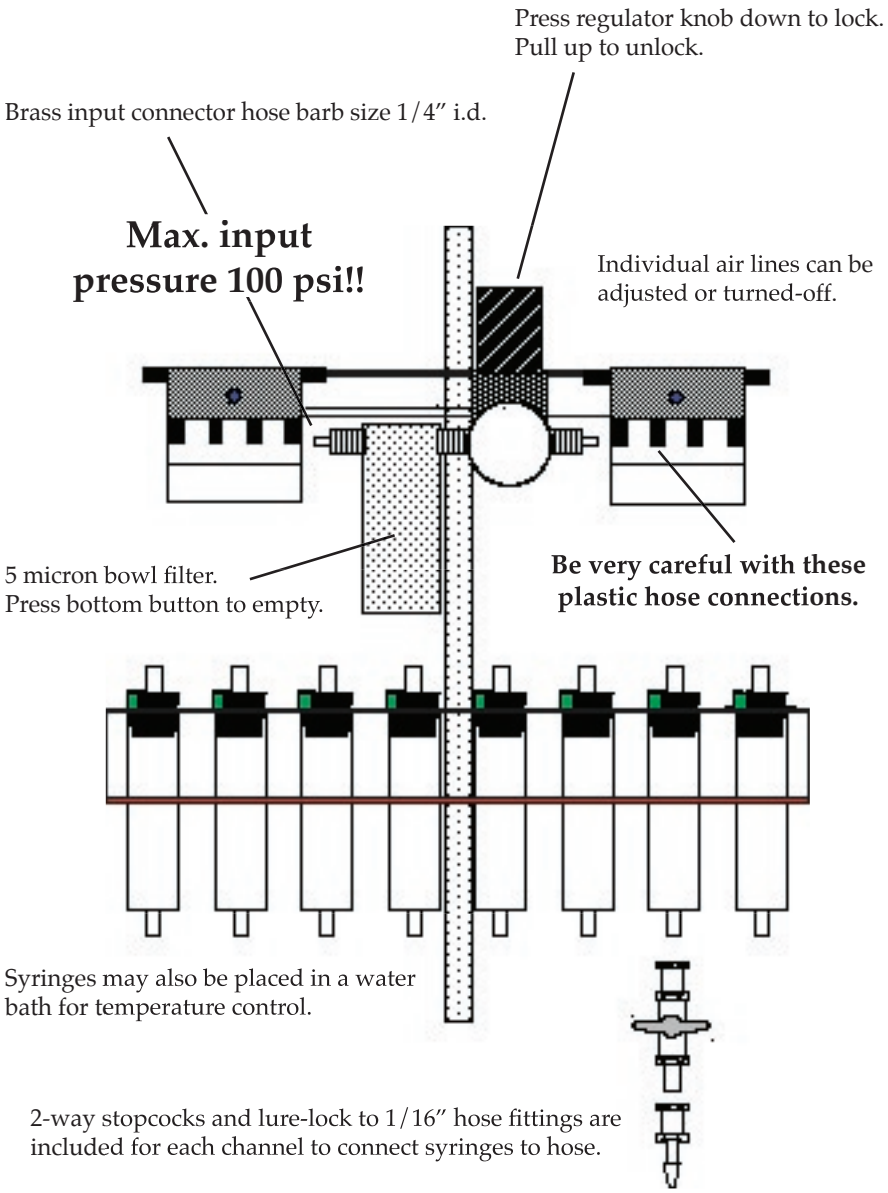
... or, for even **less dead volume**, use a short piece of 1/16" i.d. tubing over the valve barb, and piece of smaller 1/16" o.d. tubing inserted inside the valve tubing and manifold ports (you may need to supply extra small tubing for this option):

Valve with 1/16" o.d. barb
v
Short piece of 1/16" i.d. tubing over valve barb
v
Small diameter 1/16" o.d. tubing inserted inside valve tube
and inserted inside manifold ports
v
Manifold without connector tubing. 1/16" i.d. holes.

Cutting the tubing at an angle will make insertion easier. Cutting the tubing square, however, will minimize dead volume when inserted as far as possible into the manifold – being careful not block at the point of convergence.

Remember to keep all tubing as short as possible.

Perfusion Pressure Kit (sold separately #09-04, -08 & -16)

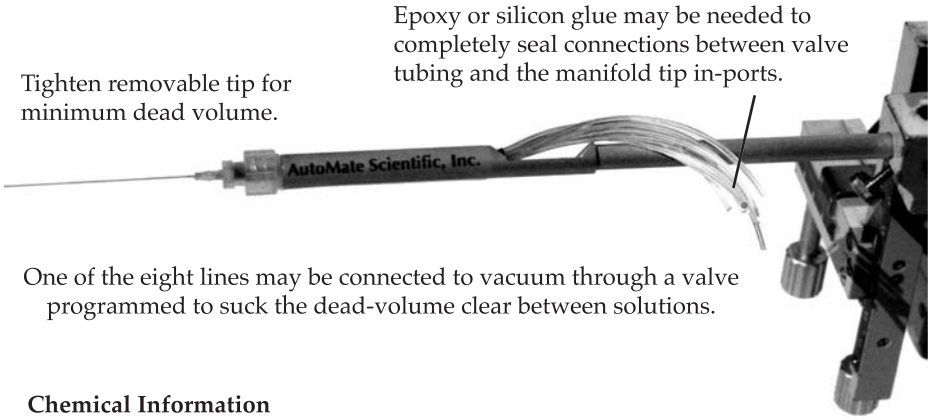

Press regulator knob down to lock.
Pull up to unlock.
Brass input connector hose barb size 1/4" i.d.
Max. input pressure 100 psi!!
Individual air lines can be adjusted or turned-off.
5 micron bowl filter.
Press bottom button to empty.
Be very careful with these plastic hose connections.
Syringes may also be placed in a water bath for temperature control.
2-way stopcocks and lure-lock to 1/16" hose fittings are included for each channel to connect syringes to hose.
Hoses should continue from syringes to valves

Multi-barrel Perfusion Pencil™ (sold separately)

#04-04-xxx	4-into-1 Pencil with tip
#04-08-xxx	8-into-1 Pencil with tip
#04-16-xxx	16-into-1 Pencil with tip
	(xxx = 100, 250, or 360 μm)

Replacement Tips:

Part No.	Description
04-xxx	specify
100, 250, or 360 μm	


Epoxy or silicon glue may be needed to completely seal connections between valve tubing and the manifold tip in-ports.
Tighten removable tip for minimum dead volume.
AutoMate Scientific, Inc.
One of the eight lines may be connected to vacuum through a valve programmed to suck the dead-volume clear between solutions.

Chemical Information

The tubing inside the manifold body is polyimide (nylon). The largest connection tubing is vinyl. The Removable tips include a medical grade polypropylene Luer-lock fitting with a fused silica (quartz) needle coated with polyimide. These materials are resistant to most acids, bases and organic solvents. To avoid dust contamination, we recommend pre-rinsing the Perfusion Pencil and Tip with distilled water. Also, it is good practice to discard the first few microliters of solution before using the device. The Perfusion Pencil and Removable Tips are shipped non-sterile. They can be chemically sterilized or autoclaved. However, repeated autoclaving may weaken the adhesive bond between the Lure-lock fitting and the needle.

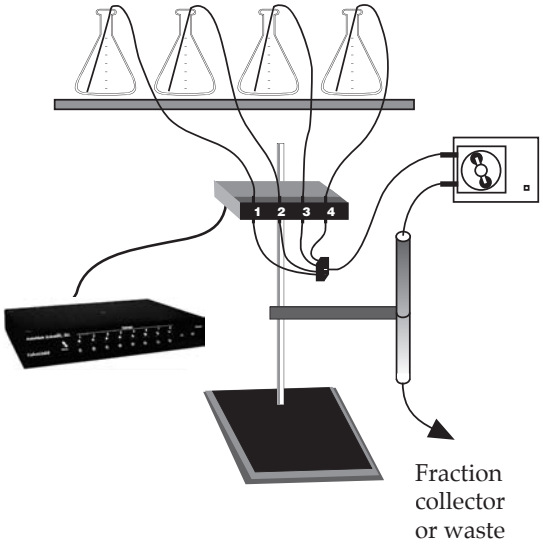
Maintenance

You can expect several years of useful lifetime for your tip if you wash it daily. Use a syringe or vacuum to pull first water, then alcohol three times each through the tip. If the Multibarrel Perfusion Pencil is filled with pure salt solution, leaving it in the syringe overnight will not usually cause the tip to block. However, if it is used for high viscosity fluids, flushing after each use is recommended.

Cutting

The Removable Tips are shipped with 1.5" (3.8 cm) length polyimide needles. They are intended to be cut to a desired length by rolling a razor blade on them against a hard surface. However, this may leave a small crack or barb on the tip. To get a flat cut, score the coating of the needle with a ceramic cleaving stone or a diamond cutter and pull directly apart, making sure not to pull at an angle. You may notice a larger outer tube enclosing the lower part of our smaller, 100μm needles. This is simply for added rigidity, and can be cut if needed.

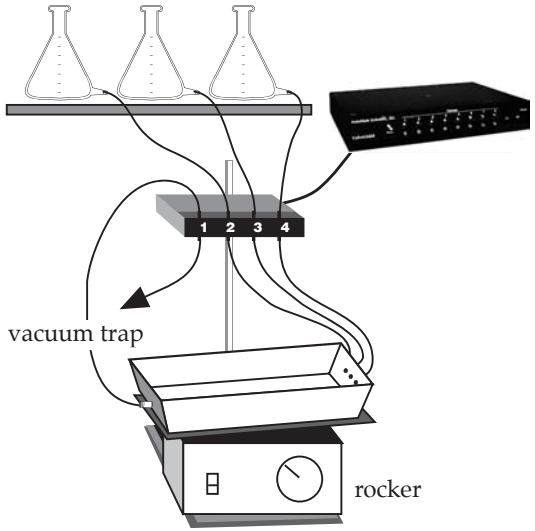
Chromatography



Without a pump, flow rate is determined by relative height of reservoirs.

1) Position reservoirs above column ringstand.
2) Attach valve unit to column stand.
3) Run tubing from upper valve barbs into reservoirs.
4) Connect short pieces of tubingbetweenlowervalve barbs and manifold.
5) Connect manifold outflow to your pump with 1/16" i.d. tubing.
6) Pump outflow connects to column inlet as usual.
7) Plug numbered valve cables

Gel/Blot Washing System



Flow rate is determined by relative height of reservoirs.

1) Position reservoirs above washing area.
2) Attach valve unit to ringstand.
3) Run tubing from upper valve barbs to reservoir nipples.
4) Connect tube from lower valve barbs to tray inlets.
5) Connect tray outflow to fourth upper valve barb.
6) Connect this valve's outflow to vacuum trap.
7) Plug numbered valve cables

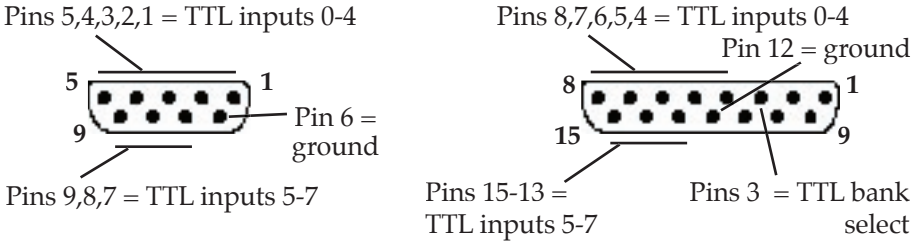
Operation

With a ValveLink8, a researcher can turn valves on and off using eight TTL pins from an interfacing board on a personal computer and their own custom programs. (See the description of Mode #1 in the next chapter to accomplish this using only three or four TTL outputs.) The ValveLink will open and close valves mirroring the computer signals (low = off, high = on) with sub-10 millisecond accuracy. ValveLink16's have one additional TTL input to 'multiply' the eight common inputs by 2 into 16 full channels of valve control.

ValveLink8 [Back panel diagram view] **ValveLink16**

Standard female DB-9 connector

Female DB-15 connector



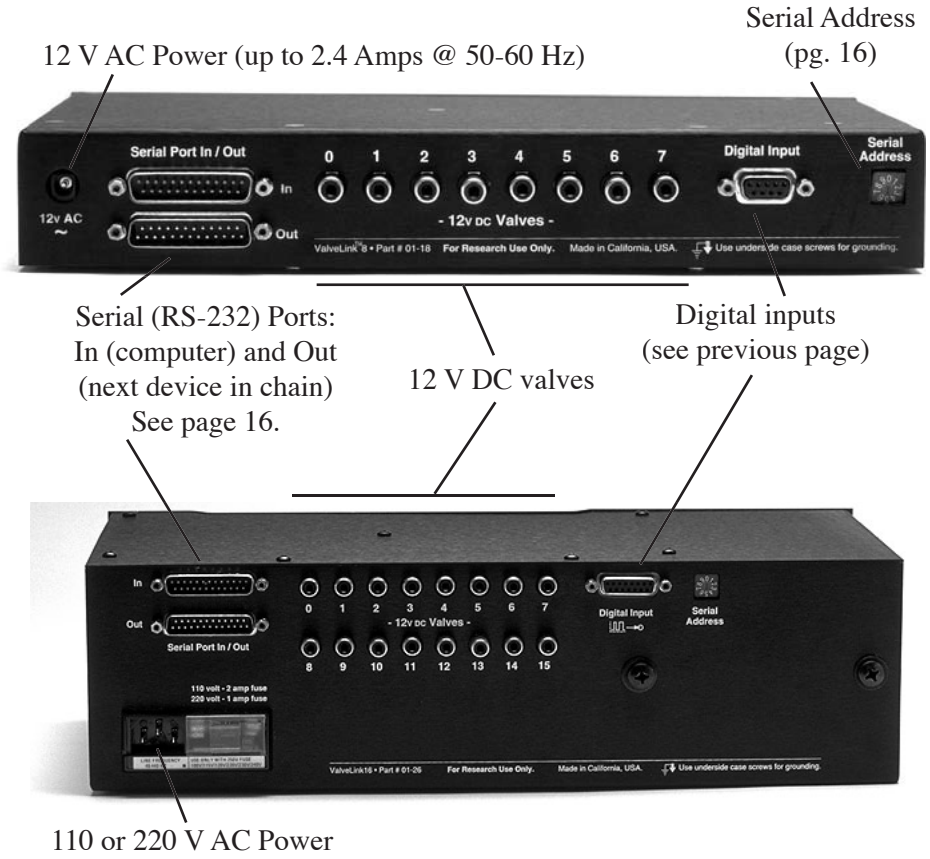
Manual Control

Each press of a front-panel pushbutton toggles its valve on and off. The 'Reset' button immediately turns ALL valves off and resets the ValveLink's internal circuitry. The ValveLink16 includes 16 valve status LED's, but has only eight pushbuttons like the ValveLink8. An up/down switch toggles the ValveLink16's pushbuttons between control of two 'banks' of eight valves.

3-way Valves

The ValveLink also supports 3-way, single-solenoid valves (2 wire). Program the ValveLink as you normally would for 2-way valves, after determining which of two inlets or outlets are opened with the on and off states.

Back Panel


12 V AC Power (up to 2.4 Amps @ 50-60 Hz)
Serial Address
(pg. 16)
Serial Port In / Out
In
Out
12v AC
0 1 2 3 4 5 6 7
- 12v DC Valves -
Digital Input
Serial Address
Serial (RS-232) Ports:
In (computer) and Out
(next device in chain)
See page 16.
12 V DC valves
Digital inputs
(see previous page)
8 9 10 11 12 13 14 15
110 volt - 2 amp fuse
220 volt - 1 amp fuse
For Research Use Only.
Made in California, USA.
110 or 220 V AC Power

Case & Valve Grounding

This equipment must be earth grounded. Use any screws on the bottom of the ValveLink case for grounding. Order AutoMate part no. 01-05 "Low noise, valve and case grounding package" for an extra grounding wire attached to each individual valve extending back to the controller. Each of this item grounds four (4) valves. Please order two for eight channel perfusion systems. This item must be ordered at the same time as the valves. Connect the ground wire from the valves to a screw on the bottom of the controller case.

Modes

The ValveLink includes several useful features as auxiliary 'Modes.' The user alters the current mode settings by holding button #0 down while powering the ValveLink on or while pressing and releasing the Reset button. LED #0 should begin flashing. Individual modes are toggled on and off by pressing their button while LED #0 is flashing. The LED associated with each button should change from red to green, with green representing ON. All of the modes can be used simultaneously, except numbers 1 and 2 which cannot both be on. Press button #0 to return to normal ValveLink operation with any modes activated.

The ValveLink cannot remember which modes are active when powered off. Therefore, all modes are deactivated when the ValveLink is turned off or unplugged. However, modes are maintained after pressing the Reset button. Hold button #0 down while resetting the ValveLink to view and change the current mode settings as described above. NOTE - Reset also closes all valves.

Mode Descriptions

#1 Binary Demultiplexed Addressing Mode (Valves 0-7 for two ValveLink8's)

TTL inputs 0-2 decode into a binary number 0-7 representing which valve to open. When this 3-bit number changes, the previous valve is closed. When Mode 1 or 2 is used, TTL inputs 0-3 are used for addressing and no longer directly control valves 0-3. Example: TTL input 0000 0101 opens valve 5 (its decimal equivalent). For ValveLink16's, additional bit 3 is used as described in the next paragraph to further select bank 2.

#2 Addressing Mode - Valves 8-15 (2nd ValveLink8)

This is the same binary decoding of bit 0-2 as Mode #1, but bit 3 is used to select between two ValveLink8's and control up to 16 valves with a single 4-bit TTL source. Set the first ValveLink8 to Mode 1, the second to Mode 2, and connect TTL input bits 0-3 from both ValveLinks to your digital output. Bits 0-2 decode which valve is opened on the ValveLink selected by the fourth bit

(high = ValveLink in Mode 2 & low = ValveLink in Mode 1). As in Mode 1, TTL inputs 0-3 are used for addressing and no longer directly control their respective valves. Example: TTL input 0000 1001 opens valve 9 (valve 1 on the second ValveLink8.)

#3 Pre-selected Valve Mode

When Mode 3 is activated, the user is prompted to press a button 0-7 immediately after leaving mode selection (all LEDs will flash waiting for a single push button selection). Thereafter, the valve selected is toggled on and off by TTL input bit #7. This mode allows a researcher to permanently connect a single TTL output to ValveLink input seven, and select which of eight valves to activate with that single TTL signal. This mode prevents input #7 from controlling valve #7 as it normally would, unless valve #7 is chosen as the 'pre-selected' Mode 3 valve.

#4 Master Valve

When Mode 4 is selected, the user is prompted to press a button 0-7 immediately after leaving mode selection (as Mode 3). This valve then becomes the master valve. Thereafter, whenever all other valves have been closed through push buttons, TTL inputs, or the serial port, the master valve will automatically open. This feature is useful if a control solution is required whenever all other solutions are stopped.

#5 One-at-a-time Mode

When active, Mode 5 automatically closes all other valves whenever a valve is opened – either by push button, TTL input, or serial input. This guarantees that no more than one valve is open at a time. The only exception to this mode is an All Open command through the serial port (code 192).

#7 4800 Baud

The ValveLink normally expects serial communications at 9600 baud. When Mode 7 is active, the ValveLink listens for serial codes at a slower 4800 baud rate.

While several modes decode the TTL inputs, the push buttons and serial input will always toggle valves according to which modes are active. Remember button #0 leaves mode setting. If Modes 3 and 4 are both active, the user will be prompted for the Mode 3 'pre-selected' valve first, then the Mode 4 'master' valve.

Multiple modes

As mentioned above, most of the six modes above can be active concurrently, such as Mode 1 - Addressing, Mode 4 - Master Valve, and Mode 5 - One-at-a-time. Valves are opened or closed accordingly. Only Modes 1 and 2 cannot both be on simultaneously.

Example mode selection LED's (red = off, green = on):

0	1	2	3	4	5	6	7
Blink	Off	**On**	Off	**On**	**On**	Off	**On**

0 blinking = mode select - press button #0 to leave
2 on = Addressing Mode valves 8-15 (2nd ValveLink8)
4 on = Master Valve
5 on = One-at-a-time Mode
7 on = 4800 baud serial rate

In this example, when button #0 is pressed to leave mode selection, all LEDs will flash waiting for the master valve (Mode 4) to be selected.

Instant mode select

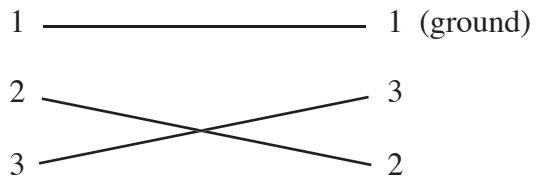
In order to ease mode selection, especially when the ValveLink is frequently turned on and off, individual modes can be selected when power is turned on. Just as button #0 is held to enter mode selection described earlier, instead simply hold down the button corresponding to the mode to be activated during power on or reset. It is not necessary to press anything to 'leave' or finish instant mode selection. Only one mode can be activated in this manner at a time. However, button #6 activates the frequently used combination of Modes 4 & 5 (master valve and one-at-a-time).

As described under Mode Selection, Modes 3, 4 and 7 each require specific valves to be designated for their function. The user will be prompted with all LED's flashing to select a 'pre-designated' or 'master' valve after using instant selection for any of these modes.

Serial Communications

All of AutoMate's controllers are capable of communicating with a host computer connected to a chain of several devices. Serial communications must be set to either 9600 or 4800 baud (see Mode 8), and must be sent over a standard null modem cable. Usually this is a normal serial cable with a null modem adapter

Null modem cable diagram



AutoMate has implemented a communications protocol compatible with the one offered by Axon Instruments. All commands begin with ATn, where n is a single digit from 0-9, indicating the device number being addressed. The address is set with the Serial Address switch on the rear of the ValveLink. All commands must be terminated with a carriage return <cr>. Possible commands are:

ATnO<cr> - Open ALL valves.
ATnC<cr> - Close ALL valves.
ATnV+v<cr> - Open valve 'v'.
ie. AT6V+3<cr> opens valve 3 on device 6.
ATnV-v<cr> - Close valve 'v'.
ie. AT5V-1<cr> closes valve 1 on device 5.

All valve and mode numbers are 1 based instead of 0 based. That is, on a ValveLink8, they range from 1-8, and ValveLink16 valves range from 1-16.

ATnM+x,x/y,...<cr> - Activate (turn on) modes.
ATnM-x,x/y,...<cr> - Deactivate (turn off) modes.

All modes are separated by commas. The modes that require parameters (4 & 5) have them specified following a forward slash, but preceding the comma that separates the next entry. For example, AT3M+2, 4/11, 5/3, 6<cr> activates modes 2, 4, 5 and 6 on device 3, with valve 11 specified for mode 4 (preselect), and valve 3 specified for Master mode (5).

Again, all valves are referred to starting with 1.

The modes for purposes of serial commands are:

1 - 'Straight through' TTL mode. The individual TTL Inputs turn valves on or off. This is incompatible with modes 2, 3, & 4; mode 1 turns them off.

2 - 'Low-bank' Binary Addressing mode. Inputs 1-3 are decoded as a binary number if the fourth TTL Input is low. Turns off mode 1.

3 - 'High-bank' Addressing mode. Inputs 1-3 are decoded as a binary number if the fourth TTL Input is high. Turns off mode 1.

4 - Preselect mode. TTL Input 8 turns the preselected valve on or off. Requires a valve number parameter. Turns off mode 1.

5 - Master mode. Requires a valve number parameter.

6 - One-at-a-Time mode.

The baud rate (Mode 8) may not be changed via the serial commands for obvious reasons.

See pages 13-15 for a complete description of these modes.

Techniques

Dead volume

Dead volume should be minimized in order to switch solutions as rapidly as possible. Dead volume for this purpose refers to the volume in the single piece of tubing between the manifold and final destination (perfusion chamber, 96-well plate, etc.) A certain amount of time must pass for a new liquid to clear the previous one from this final piece of tubing. Solution switching takes place at the manifold - assuming each channel's tubing has been primed from its valve to this point. Therefore, the manifold should be positioned as close to the ultimate destination as possible, while the valves can be some distance away. The micro-manifolds available from AutoMate Scientific are designed to be inserted without tubing directly into orifices in some perfusion chambers. This absolutely minimizes dead volume – resulting in switching times of under a second.

AutoMate Perfusion Systems include a blue disposable flow regulator which will *increase* dead volume if used improperly. The regulator can either be eliminated if controlling flow rate is not necessary, or positioned *before* the manifold to eliminate dead volume. However, this second method only controls the flow rate of individual solutions (instead of all solutions when located after the manifold). Therefore, the researcher can either limit the flow of a single liquid, or purchase flow regulators for each line.

A final method for reducing dead volume is to use smaller bore tubing, although this may also reduce flow rate resulting in the same switching time as for larger tubing.

Small bore, Teflon tubing

AutoMate Scientific's micro-manifolds use 1/16" o.d. tube ports which can either be used with this size tubing, or enlarged up to 1/16" i.d for valve hose barb fittings. Please inquire about AutoMate's Teflon tubing and nut and ferrule valve fittings for small bore use. Also see the micro-manifold instructions on page 7.

Cutting Teflon tubing at an angle makes it easier to insert.

Backflow

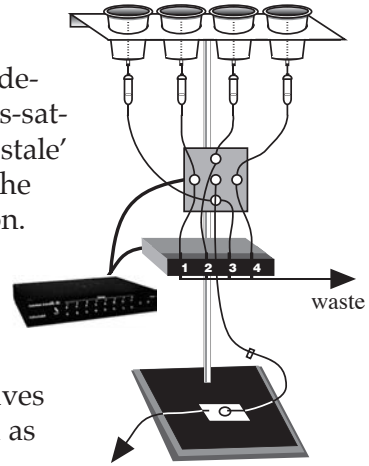
When a manifold is used in a plumbing arrangement, none of its ports can be left unconnected, or liquid will simply flow backwards out of the opening. Small, green hose clamps are included with AutoMate Perfusion System drippers which can be easily attached to short pieces of tubing to act as plugs for unused holes.

Likewise, one must be careful not to open any valve whose reservoir is completely empty or inflow tube is disconnected. Ordinary solution pressure in other lines will force liquid back up the outflow tubing, through the valve, and either back into the reservoir or out the disconnected inflow onto the floor. Again, clamp-off any unused lines at the manifold or be sure all valves are closed while changing connections.

Syringe reservoirs

AutoMate offers 30ml syringes (photo on page 3) as alternatives to its 100ml polypropylene reservoir cups. Connected directly into luer lock fittings in the valves, this method eliminates wasted solution in tubing between the reservoirs and valves. Small 2-way stopcocks are included when this option is ordered. These are placed between the syringe and valve fitting in case syringes must be disconnected before completely empty. Simply loosen the luer lock *from the valve fitting*, and remove the syringe and stopcock together. These stopcocks are also useful if there is a chance of a valve opening after its reservoir is empty (see above paragraph).

AutoPrime™ System



The AutoPrime Perfusion System is designed to deliver oxygenated (or other gas-saturated) solutions without administering 'stale' liquid which has remained stationary in the tubing long enough to lose its oxygenation. Unless one uses 'hard-walled' (i.e. Teflon) tubing, gas will escape through the tubing leaving the stale solution with a ruined pH and gas concentration. The 8-channel AutoPrime System uses eight valves per four liquids, with the second set used as

'flush' valves to waste. Shortly before a solution is to be switched 'on,' its flush valve opens and re-primes the upper tubing with fresh solution from the reservoir down to its delivery valve (where a tee fitting is located connected to the flush valve.) The flush valve is then closed, and the delivery valve can be opened. The previous solution in a delivery sequence can continue to flow while re-priming occurs.

Faulty valves

The bane of all liquid delivery apparatus! Despite AutoMate's best efforts and pursuit of high quality valve manufacturers, some valves fail. How often have space shuttle launches been delayed due to valve problems? We can only pass along our valve supplier's one year warranty with their disclaimer "Improper use or mishandling of the units, in the opinion of the manufacturer, voids this warranty!" (their exclamation mark too.) In order to minimize valve problems, please observe these guidelines:

1) Clean your valves after each use. Accumulated debris or precipitate will rapidly cause leaking valves and seals. Use an in-line filter if you expect a chance of particles in your solutions. Put your AutoMate controller's programmability to good use by writing a washing protocol. At the end of the day, fill each reservoir with cleaning solution (distilled water or appropriate liquid), and press Start. A protocol can be easily written to flush each valve in sequence. Saline solutions allowed to dry in stainless steel valves will cause them to rust. This is considered improper use. We also recommend rinsing your valves once before their first use.

Beware of flaking Teflon tape or silicone fitting glue. Large debris are often the cause of valve failure. Try backflushing a valve that is suspected to have failed for this reason by connecting a lightly pressurized liquid to the *outflow* of the valve while it is energized. Sometimes this ejects the clog. No Draino!

2) Do not operate AutoMate valves with homemade controllers delivering over 12V DC, or attempt to cycle them rapidly <10ms.

3) Do not exceed the rated operating pressure (> 100psi).

Before returning any valves to us please check:

1) That it was purchased in the last 12 months (AutoMate and valve manufacturers record each by serial number.)

2) That the valve is faulty and not the controller channel – find a valve that works in a particular output channel and try the bad valve in that port to see that it still does not function.

3) If it is leaking, see #1 above and the section below.

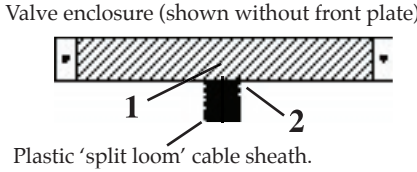
If it qualifies for all three of the above, AutoMate will accept the valve for subsequent return to the factory. Repair or replacement is at their discretion, as AutoMate does not have the ability to open the valves to determine the cause of trouble. We may be able to loan replacement valves, which may be billed if the valve factory finds abuse on the user's part and refuses to honor the warranty.

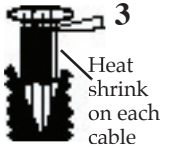
Stuck pinch Valves

Occasionally pinch valves will stick closed. Usually this is a sign that they are about to completely fail, but sometimes they can be rejuvinated by simply prying them open. First energize (turn on) the valve; then, using a flat screwdriver, gently force the white plunger open where it normally pinches the tube closed. The valve may begin functioning normally. Also, **pinch valves will not usually work without a piece of pinch tubing installed.**

Valve Cables

One problem that is easy to diagnose and fix is a broken cable connection. Use any ohmmeter to measure the resistance across the inner pin and outer 'barrel' of the RCA plug end of the valve cable (while unplugged from the controller.) A resistance of zero ohms indicates a short, or infinite resistance means one of the wires is broken in the cable assembly. This occurs most often at the joint between the heavy black cable and the valve lead wires – under the heat-shrink tubing, inside the outer black sheath, a few inches from the valve itself. This can often be reached without completely disassembling the valve enclosure. Simply 1) remove the screw inside the black valve box holding the plastic sheath in its hole, 2) remove the black tape at the top of the sheath and peel it back a couple of inches, find the offending cable (trace it back from the bad valve), and 3)





carefully slice its heat-shrink tubing longitudinally to remove it. The wires may have come apart or broken here, inside the next piece of electrical tape isolating the two leads, otherwise within the cable or valve itself (which can be further determined with the volt/ohmmeter). If you find the break, resolder the connection, wrap the inner wires in separate pieces of electrical tape, retest the valve, and reassemble the sheath following the above instructions in reverse order.

Valve returns & Replacing a Valve

If you need to return a defective valve, you may either return the entire valve assembly for repair / evaluation, or remove and return the individual valve from its case. This only involves five screws: remove the two outer plate screws holding all of the valves into the black metal case, the single screw holding the plastic 'sheath' into its underside hole, the electrical tape at the top and bottom of the sheath, the offending valve's cable from the plug end up through the valve casing, and finally, the two screws holding the valve on to the front plate.

Please package the valve(s) carefully and ship freight prepaid to AutoMate's address on the back cover of this manual. **No RMA number is needed** as long as you include a note with the following:

1) Your name, company/institution name, phone number, and an address to return the repair to.

2) Your original invoice number and date if available.

3) A sentence stating the nature of the problem and any steps you have already taken to fix or identify it. Does the valve energize / click? De-energize? Open / close? Leak?

4) Whether the valve was driven by any device *other* than an AutoMate controller (and its operating and holding voltages).

5) The application used with the valve, along with the exact chemical(s) and the duty cycle (pulse) rate if used.

6) A Statement of Chemical Exposure as follows:
a) These valves have not been exposed to chemicals other than H_2O except as described above. b) All applicable Safety and Handling data sheets for the above described chemicals are enclosed. c) We accept full responsibility for any injury to AutoMate employees or employees of the valves original manufacturer caused by handling of the residues of chemicals contained in or on the valves to be returned.

7) An authorized signature, title, and date.

AutoMate will gladly fax you a form with easy blanks to enter the above information. We will process your return and notify you of further information as quickly as possible.

Leaks & Replacing valve fittings

The second bane of all liquid delivery apparatus! These hints may help:

1) Make sure the valve is turned off! (as opposed to leaking)

2) See all of the guidelines in the previous "Faulty Valves" section - especially #1.

3) Identify whether the valve leaks constantly, under pressure, inside or outside. Try backflushing if an internal leak.

4) Check and replace obvious loose or worn tubing.

5) Outside leaks usually occur at the fittings and can be stopped with a bit of silicone glue, epoxy, super glue (Cyanoacrylate) or Teflon tape around the threads of the dry fitting screwed back into the valve. Be sure not to use too much glue or tape, as they can easily cause clogs or leaks of their own. **Overtightening can also cause the plastic fittings to leak – hand tighten.**

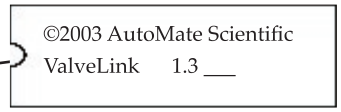
Glue on valve fittings is intended as a gap filler for small openings between the threads and hole, not as an adhesive. Few glues will adhere to Teflon.

Hardware troubleshooting

Should the ValveLink LED's fail to light while power is turned on, check your power connections, source and on/off switch. Disconnect all valves to check for a short. Check the back panel fuse on ValveLink16's. Finally, if all else fails, unplug the ValveLink and check the fuse on the internal circuit board following these instructions: ValveLink8 – remove all of the screws on the bottom and 6 hex D-connector screws from the rear; or ValveLink16 – remove all of the screws from the top cover. Only replace the fuse with a standard (not slow-blow) of the same size. One extra fuse is included on the circuit board in clips labeled "Spare."

EPROM Installation Instructions

1) Open the ValveLink case as described in the preceeding paragraph. Remove the last EPROM slowly with a flat screwdriver or IC remover noting the 'dimple' orientation (pin 1) on its left side. Insert the new chip with the same orientation – being careful not to bend any pins.



2) Make sure that the ValveLink turns on, then turn it back off before reinstalling the case top. Save the old EPROM until you are completely satisfied with the new one.

EPROM's can be erased and recycled, and they cost around $3.99 each. So if you're happy with an upgrade, it's worth the few pennies stamp cost for U.S. customers to drop them in an envelope back to AutoMate. International (or busy U.S.) customers will be excused if they cannot return old [useless] eproms. :-)

Safety Instructions

The following instructions pertain to the risk of fire, electric shock, or bodily injury. Please read all of these instructions carefully.

1. Follow all the instructions and warnings marked on this product or included in this manual.

2. Do not use this product on an unstable cart, stand, or table. This product may fall, causing serious damage to the product.

3. Slots and openings in the cabinet and the back are provided for ventilation. To ensure the reliable operation of your product, and to protect it from overheating, these openings must not be blocked or covered. Do not use this product on a bed, sofa, rug or other similar surfaces. This product should never be placed near or over a radiator or heat register. This product should not be placed in a built-in installation unless proper ventilation is provided.

4. Never push objects of any kind into the product through the cabinet openings, as they may touch dangerous voltage points or short-out parts that could result in fire or electric shock. Never spill liquids of any kind in the product.

5. This product should only be connected to the AC power source indicated on your product system's information label. If you are not sure of the type of AC power available, consult your dealer or local power company. Only connect this product to a power outlet that matches the power requirements of this product.

6. Do not allow anything to rest on the power cord. Do not locate this product where people will walk on the cord.

7. If you have to use an extension cord with this product, make sure that the total amperage rating of all equipment plugged into it does not exceed the amperage rating of the extension cord. Also, make sure that the total of all products plugged into the main AC power outlet does not exceed 15 Amps.

8. Unplug your product from the main electrical power before cleaning. Do not use liquid cleaner or aerosol cleaners. Use a damp cloth for cleaning.

9. Do not use this product near water.

10. Unplug this product from the main power outlet and call for service under any of the following conditions:

A. If the power cord or plug is damaged or frayed.
B. If liquid has been spilled into the product.
C. If the product has been exposed to rain or water.
D. If the product has been dropped or the cabinet has been damaged.
E. If the product exhibits a distinct change in performance, indicating a need for service.

STOP!!

If you ever have to remove the main system unit cover, observe the following precautions:

A. The power supply cord must be unplugged before the main system unit cover is removed. (Separe le cordon d'alimantation et puis enleve le couvercle.)

B. Once removed, the cover must be replaced and screwed in position before the power supply is plugged back in. (Apres le couvercle en place et remettre le cordon d'alimentation.)

Battery Warning Statement

CAUTION

There is a danger of explosion if the battery is replaced incorrectly. Replace only with the same or equipment type recommended by the manufacturer. Discard used batteries according to the manufacturer's instructions. See inside of front cover for battery specifications.

ATTENTION

Il y a danger d'explosion s'il y a remplacement incorrect de la batterie. Remplacer uniquement avec une batterie de meme type ou d'un type recommande par le constructeur. Mettre au rebutled batteries usagees conformement aux instructions du fablicant. See inside of front cover for battery specifications.

VORSICHT

Explosionsgefahr bei unsachgemass em Austausch der Batterie. Ersatz nur durch denselben oder einen vom Hersteller empfohlenen ahnlichen Typ. Entaorgung gebraushter Batterien nach Angaben des Herstellers. See inside of front cover for battery specifications.

Warranty

AutoMate Scientific, Inc. warrants its products against defects of workmanship and/or material for **ONE YEAR** from the date of sale. Any product that fails to perform as specified may be returned, freight pre-paid to the factory (with a written explanation of the problem) for examination and repair or replacement. If it is defective, AutoMate Scientific will repair or replace (at our option) the product without charge and return it to you.

If the examination indicates that non-compatible fluid, destructive environment, accidental damage, modification or abusive practices have occurred, all labor, materials and freight costs shall be at the expense of the customer.

Due to the nature of clinical laboratory applications, AutoMate Scientific, Inc. will **NOT** accept the return of any products which have been used with **HAZARDOUS MATERIALS** or harmful environment.

This warranty is in lieu of all other warranties, whether oral or written, express or implied. In no event shall AutoMate Scientific, Inc. or its licensor/licensees be liable for contingent, special, direct, indirect or consequential damages for the breach of any express or implied warranty or resulting from the use, failure or malfunction of any product, including damage to property and, to the fullest extent permitted by law, damages for personal injury, even if AutoMate Scientific, Inc. has been advised of the possibility of such damages or if this warranty is found to fail its essential purpose. AutoMate Scientific, Inc's liability is limited to the reimbursement of the cost of the product. All other warranties, including, but not limited to warranties for fitness or merchantability for a particular purpose are expressly excluded. No verbal changes to this policy will be authorized.

AutoMate Scientific, Inc. manufacturers and sells goods in accordance with U.S. federal, state and local laws, but assumes no responsibility or liability for laws, regulations, duties, or taxes imposed by any foreign country. All terms and conditions hereof shall be governed by the laws of the State of California.